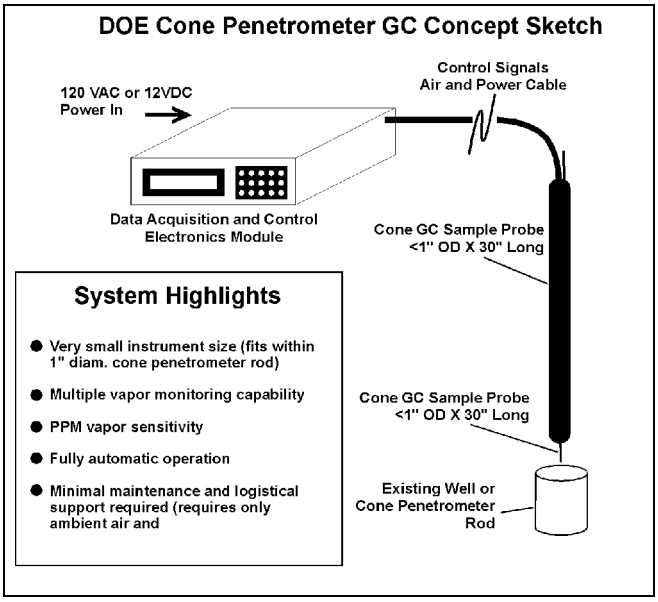
Miniature GC for In-Situ Monitoring of Volatile Organic Compounds Within a Cone Penetrometer

Developer: Microsensor Systems
Contract Number: DE-AR21-94MC31187
Crosscutting Area: CMST

Subsurface Contaminants FOCUS AREA



Problem:

A key piece of information required for site characterization is the concentration and identity of chemical pollutants present in the soil. Cone penetrometry has emerged as a powerful method for providing rapid vertical profiles of the soil composition at remediation sites. There is a need for a chemical sensor that can be incorporated into the cone penetrometer rod assembly (typically 1 inch to 1-1/4 inch inside diameter) that is pushed into the soil. Current methods involve collection of grab samples and subsequent analysis at a laboratory. Such methods are time consuming and expensive. Thus, the problem is to develop a very compact chemical sensor that is small enough to fit within the bore of the cone penetrometer rod, sensitive enough to measure pollutant chemicals at environmentally relevant concentrations (e.g., 1 ppm to 1,000 ppm), and capable of providing information about the identity of the polluting chemicals.

Solution:

Develop an extremely compact gas chromatograph (GC) that can fit inside the one inch internal diameter of a cone penetrometer rod. By taking an in situ measurement, the Cone GC can establish a stratigraphic contamination emission profile with no sample handling.

The Cone GC offers the unique capability of being able to go to the sample collection zone instead of the sample being collected and brought back up to an instrument on the surface. This will avoid the need for long sample collection lines, pumps and syringes, etc., thereby providing a significant cost savings and faster data analysis. An additional use of the Cone GC would be the insertion of the instrument at the perimeter of a hazardous waste area to gauge the potential migration of volatile organic contamination across the monitored zone.

Benefits:

- In situ chemical vapor monitoring
- Extremely compact gas chromatograph can be used in diverse environmental monitoring applications
- Fully automatic, low power consumption, relatively low cost
- Very effective for monitoring chlorinated hydrocarbons

Technology:

The Cone GC has two main subsystems: a sensor probe and a controller module.

The Cone GC sensor probe contains a sampling pump, a sample loop, an 8-port motor driven injection valve, an oversized (60°C) isothermal 1/16 inch outside diameter packed chromatographic column, and a solid state detector along with associated electronics. The sensor probe is 0.987 inches in diameter and is approximately 30 inches long. It is connected to the controller module by means of an electrical cable (to supply 6V DC power and control signals) and a 1/8 inch OD plastic hose to supply compressed air carrier gas to the GC. The relatively short, packed GC column was selected to provide a compromise between the conflicting demands of short analysis time, good resolution, and robustness.

The Cone GC controller module contains a microcomputer data acquisition system, a miniature air compressor for carrier gas, and a power supply for the sensor probe. The complete module occupies about 1/3 of a cubic foot, and weighs less than 12 pounds. The instrument is easily programmed to monitor multiple analyses using a self-contained keypad and liquid crystal display (LCD). The controller module provides fully automatic data acquisition and control of the sensor probe. Chromatographic results can be displayed, printed or archived. The system is entirely self-contained and only requires 120V AC or 12V DC power (20 watts avg.) and ambient air or the carrier gas compressor.

The Cone GC sensor probe is designed to accommodate several different solid-state detectors including SAW devices, metal oxide semiconductors, and solid-state electrochemical diodes. The electrochemical diode detector is extremely selective for halogenated hydrocarbons and responds well to compounds such as carbon tetrachloride and perchlorethylene, compounds that are frequently found at DOE sites and are difficult to monitor using many other conventional instruments.

Project Conclusion:

This project was completed in May 1996. Prior to project completion, the technology development contractor tested the system above ground at the contractor's facility and found that it essentially worked as planned. The project was discontinued at the end of the base contract period due to lack of DOE need for this technology, given the advancing development of other instruments for similar applications.

Contacts:

This project is being conducted by Microsensor Systems, Inc. The Cone GC will be commercialized by the company and offered as one of their products. For information on this project, the contractor contact is:

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DOE's Morgantown Energy Technology Center supports the Environmental Management - Office of Science and Technology by contracting the research and development of new technologies for waste site characterization and cleanup. For information regarding this project, the DOE contact is:

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